

22.

Some Tropical Fishes as Hosts for the Metacercaria of *Clinostomum complanatum* (Rud. 1814) (= *C. marginatum* Rud. 1819).

ROSS F. NIGRELLI.

New York Aquarium.

(Plates I & II).

The following fishes received by the New York Aquarium were found infected with the yellow grub stage of *Clinostomum*: *Chriopeops goodei* (Jordan) from Florida; *Mollienisia velifera* (Regan) from Yucatan; *Piabucana* sp. from the Amazon drainage; *Corynopoma riisei* Gill from British Guiana; *Nannostomus trifasciatus* Steindachner from the Tucantins, a tributary of the Amazon; *Lebistes reticulatus* (Peters) from out-door pools in Florida; *Hypopomus artedi* Kaup from the Amazon drainage in eastern Brazil; and *Sternopygus macrurus* (Bloch and Schneider) from the Amazon drainage.

In some instances the fishes showed no infection when they arrived, and only after they had been in the Aquarium for some time did the cysts appear. Whether the fishes were originally infected and growth of the parasite had taken place in the tanks, or whether the fishes acquired the infection in the tanks is difficult to determine. Examination of snails and water of the aquaria showed no fork-tailed cercariae.

In cases of severe infection the death of the host resulted. The trematodes were usually encysted in the fish, and in *Corynopoma riisei* the grub was embedded deep in the peculiar transparent muscle of the body (Pl. I, Figs. 1 & 2). In the gymnotid, *Sternopygus macrurus*, 16 cysts were found distributed along both sides of the base of the elongated ventral fin.

Observations on the "guppy" showed that, since this species is not influenced by seasonal changes, the cysts are not deserted as reported by Ward (1918) for northern forms. The parasites were present on the fish (Pl. II, Fig. 3) for more than a year. In one of the specimens found dead, moribund metacercariae were still in the cysts. Many of the temperate zone fishes in the Aquarium were also found infected with the metacercariae of *Clinostomum*. In the majority of instances the worms were encysted on the membrane between the rays of the fins. These cysts appeared in the spring and in winter were absent.

Examination of the parasites showed no morphological differences between the metacercariae found on tropical forms and those of temperate zone species. In all instances the worms have been identified as *C. complanatum* (Rud. 1814) (= *C. marginatum* Rud. 1819) (Pl. II, Figs. 4 & 5).

The metacercaria of *C. complanatum* has been found on a large number of fish hosts throughout the world. As *C. marginatum* it has been reported by several investigators from the following neotropical fishes (see Baer 1933): *Adnia* (*Adinia*?) *dugesii* (Bean), *Callichthys asper* Quoy and

Gaim., *Poecilia vivipara* Bloch and Schneider, *Chaetosomus brachyurus* (Kner), *Cynodon scomberoides* (Cuv.), *Satanoperca papatera* (Heck.), *Chaetobranchius flavescens* Heck., *C. gulosus* (Cuv. and Val.), *Crenicichla johanna* Heck., *Crenicichla saxatilis* (Linn.).

These are definitely Central and South American species of fishes, but because of the terminology employed, it is difficult to determine which form is referred to, since in the present day usage some of the above genera have been split up and others have been discarded. In North America the metacercaria has been reported from a large number of fishes, several species of amphibians (*Rana clamitans*, *R. pipiens*, etc.), and, according to Hopkins (1933), the parasite was found in a snake (*Thamnophis radix* (Baird)) by van Cleave.

The following are some of the North American fishes found infected: *Perca flavescens* (Mitchill)¹ (yellow perch); *Aphredoderus sayanus* (Gilliams) (pirate perch); *Micropterus dolomieu* Lacépède¹ (small mouthed black bass); *M. salmoides* (Lac.)¹ (large mouthed black bass); *Ambloplites rupestris* (Raf.)¹ (rock bass); *Lepomis pallidus* (Mitchill)¹ (bluegilled sunfish); *L. auritus* (Linn.)¹ (red-breasted sunfish); *L. cyanellus* Raf.¹ (green sunfish); *Eupomotis gibbosus* (Linn.)¹ (common sunfish); *Catostomus commersoni* (Lac.)¹ (common sucker); *Pimephales promelas* Raf. (fathead minnow); *Semotilus atromaculatus* (Mitch.) (horned dace); *Ameiurus nebulosus* (Le Sueur)¹ (common bullhead); and *Salvelinus fontinalis* (Mitch.) (brook trout). In Europe Ciurea (1911) reported the yellow grub of *C. complanatum* on *Perca fluviatilis* Linn., and Maccagno (1933) found it on the loach, *Cobitis taenia* Linn. In Japan Yamaguti (1933) found it under the skin and flesh of *Carassius carassius* Linn., *Pseudogobio esocinus*, and *Acheilognathis intermedia*.

The following are other species of *Clinostomum* described from fishes:

1. *C. heterostomum* (Rud. 1809) from European fishes, and from an unidentified species taken in the Vaal river, Africa (Monnig 1926).
2. *C. dimorphum* (Diesing 1850) from many of the tropical fishes mentioned above.
3. *C. dictyotum* (Monticelli 1893) (= *Clinostomatopsis reticulata* (Looss 1885)) from an unidentified silurid of Costa Rica.
4. *C. africanus* Stoss. from the intestine of an unidentified fish of the French Congo (see Galli-Valerio 1906).
5. *C. piscidium* Southwell and Prashad 1918 from *Trichogaster fasciatus* and *Nandus nandus* of Ceylon, and from *Trichogaster pectoralis* and *T. trichopterus* of Siam (Pearse 1933).
6. *C. intermedius* Lamont 1920 from the silurid, *Rhamdia quelen* Quoy and Gaimard.
7. *C. chrysichthys* Dubois 1930 from *Chrysichthys kingselyi* Gunth., a silurid of Angola.
8. *C. clarias* Dubois 1930 from *Clarias angolensis* Steind., a silurid of Angola.
9. *C. dalgi* Tubangiu 1933 from the eye-socket and pericardium of *Ophiocephalus striatus* Bloch., a Philippine fish.

Four orders of fishes are represented by the hosts of *Clinostomum* reported in the literature. Arranged according to the number of species found infected, these are: Ostariophysii, Acanthopterygii, Haplomi, and Isospondyli. With the exception of the Isospondyli, all are basically pond fishes. In the great majority of ponds the same relationship among these orders probably exists; that is, the Ostariophysii includes the largest number of species to be found in such a habitat, the Acanthopterygii the next largest, etc.; and likewise as to number of individuals. The Isospondyli is repre-

¹ Species present in the Aquarium on which *Clinostomum* was found.

sented by one species, *Salvelinus fontinalis* (brook trout). It is altogether possible that this form became infected during an excursion into still water, which it sometimes makes.

It is not surprising to find that pond fishes show the highest incidence of infection. The nature of the cercaria of *Clinostomum* is such that it would be mechanically difficult to infect fishes in a fast stream. These cercariae are fork-tailed organisms which float at the surface. The pond fishes, moreover, are more sluggish than the stream forms, thus making it more feasible for the cercariae to penetrate the skin.

The genus *Clinostomum* was erected by Leidy (1856) for a metacercaria found encysted in the skin of the common sunfish, *Pomotis vulgaris* C. and V., *Eupomotis gibbosus* (Linn.), and in the intestine of *Esox* sp. This species he called *C. gracile* and designated it as the type of the genus. *C. gracile* Leidy 1856, however, is considered a synonym of *C. complanatum* (Rud. 1814), an adult form taken from a heron (*Ardea cinerea*) by Rudolphi and described by him as *Distomum complanatum*. Braun (1901) made *C. complanatum* the type of the genus because Leidy's description was inadequate and because the original type was lost. There is no doubt, however, that the yellow grub, called *C. marginatum* by most North American investigators and even now found on the type host and in the type locality, is Leidy's *C. gracile*. Braun (1899) considered *C. marginatum* (Rud. 1819) a synonym of *C. complanatum* (Rud. 1814) because the two were morphologically the same and were found as metacercaria on fishes and as adults in the same genus of birds (*Ardea*). Baer (1933) expressed the same opinion and added that the geographical distribution of the two was alone not sufficient to warrant regarding them as distinct species.

According to Baer (1933) *C. heterostomum* (Rud. 1809) = *Euclinostomum heterostomum* (Rud. 1809), and *C. dimorphum* (Diesing 1850) = *Ithyclinostomum dimorphum* (Diesing 1850). In *Euclinostomum* Travassos 1928 the intestinal branches have long lateral diverticula, sometimes ramifying. In *Ithyclinostomum* Witenberg 1926 the lateral diverticula are short and never ramifying. This genus is further separated from *Clinostomum* on the distribution of the vitelline glands. In the latter these glands extend into the anterior part of the body.

The complete life history of *C. complanatum* was only recently worked out. It was known for some time that the adult worms could be found in the oral cavity of herons (*Ardea*) and related birds (Osborn 1911, 1912). In this country Hunter and Hunter (1934, 1935) showed that when the eggs of the parasites drop from the mouth cavity of the definitive host into water, they hatch into miracidia which penetrate the liver of snails. Two gastropods, *Helisoma campanulatum* (Say) and *H. antrosom* (Conrad), were experimentally infected. In the snail each miracidium develops into a sporocyst which produces rediae. The rediae in turn produce daughter rediae which become fork-tailed cercariae. These emerge from the snail and encyst as metacercariae, commonly called yellow grubs, on fishes. When an infected fish is eaten by a bird, the larvae are released and grow to maturity in the oral cavity.

Of the several species of *Clinostomum* described from fishes, the only other forms in which the adults are definitely known are *C. heterostomum* and *C. dimorphum* from ardeiform birds, and *C. intermedius* from the cormorant (*Phalacrocorax vigua*). Without doubt, however, a life-cycle similar to that of *C. complanatum* may be expected in the entire genus.

The following are species of adult *Clinostomum*, described from various definitive hosts, of which neither the first nor the second developmental stages are known: *C. dubium* Leidy 1856, *C. detruncatum* Braun 1899, *C. foliiforme* Braun 1899, *C. heluans* Braun 1899, *C. lambitans* Braun 1899, *C. sorbens* Braun 1899, *C. hornum* Nicoll 1914, *C. australiense* Johnston

1916, *C. pusillum* Lutz 1928, *C. phalacrocoracis* Dubois 1931, and *C. lophophallum* Baer 1933.

Two species of *Clinostomum* have been described from amphibians. Cort (1913) believed that the *C. marginatum* reported from batrachians (Wright 1897; Osborn 1911, 1912) was a distinct species, which he called *C. attenuatum*. His separation is based principally on certain morphological characteristics. He designated the American bittern as the probable definitive host of the metacercariae in amphibians, but Alvey and Stunkard (1932) reported *C. attenuatum* from the great blue heron. Hunter and Hunter (1934) demonstrated in feeding experiments that the great blue heron could be infected with metacercariae taken from frogs, but that the rate of infection was not as high as with *C. marginatum* from fish. They further showed (1935 a, b) that when both sunfish and tadpoles were exposed to the cercariae of *C. marginatum*, the sunfish became infected while the tadpoles remained free of metacercariae. They concluded that *C. attenuatum* is a distinct species. The other *Clinostomum* reported in amphibia is *C. pseudoheterostomum* Tubangui 1933, which occurs in the thigh muscle of a Philippine frog (*Rana magna*). The adult of this species, however, is unknown.

REFERENCES.

- ALVEY, C. H. and H. W. STUNKARD (1932). *Clinostomum attenuatum* from the great blue Heron. *J. Para.* 19: 174.
- BAER, J. G. (1933). Note sur un nouveau trématode *Clinostomum lophophallum* sp. nov. avec quelques considerations générales sur la famille des Clinostomidae (Trematoda). *Rev. Suisse Zool.* 40: 317-342, 3 figs.
- BRAUN, M. (1899). Ueber *Clinostomum* Leidy. *Zool. Anz.* 22: 484-493. (1901). Die Arten der Gattung *Clinostomum* Leidy. *Zool. Jahrb. Syst.* 14: 1-48, pls. 1, 2.
- CIUREA, J. (1911). Eine europäische *Clinostomum*-larvae. *Zbl. Bakter. Paras. Originale* 60: 354-358.
- CORT, W. W. (1913). Notes on the trematode genus *Clinostomum*. *Trans. Amer. Micr. Soc.* 32: 169-182, pl. 9.
- DUBOIS, G. (1930). Deux nouvelles Espèces de Clinostomidae. *Bull. de la Soc. Neuchâteloise des Science Naturelles.* 54: 61-72, figs. 1, 2; pls. 1, 2.
(1931). Matériaux de la mission scientifique suisse en Angola. Trematoda. *Bull. de la Soc. Neuchâteloise des Science Naturelles.* (1930) 55: 73-88, 15 figs.
- GALLI-VALERIO, B. (1906). Michele Stossich und seine helminthologischen Arbeiten. *Centralbl. Bakt. Parasit. Orig.* 42: 49, fig. 2.
- HOPKINS, S. H. (1933). Note on the life-history of *Clinostomum marginatum* (Trematoda). *Trans. Amer. Micr. Soc.* 52: 147-149, pl. 24.
- HUNTER, G. H. and HUNTER, W. S. (1934). IX. Studies on Fish and Bird Parasites. *Suppl. 23rd. Ann. Rep't. N. Y. State Conserv. Dept., 1933*, no. 8, *Rep't. of a Biological Survey of the Raquette Watershed.* 4 figs., 2 tables.
(1935 a). IX. Further studies on Fish and Bird Parasites. *Suppl. 24th Ann. Rep't. of the N. Y. State Conserv. Dept., 1934*, no. 9, *Rep't. of a Biological Survey of the Mohawk-Hudson Watershed.* 267-283, pls. A-C, 3 tables.
(1935 b). Studies on *Clinostomum*. IV. Notes on the penetration and growth of the cercaria of *Clinostomum marginatum*. *J. Para.* 21: 1, 2.
- JOHNSTON, S. J. (1916). On the Trematoda of Australian Birds. *J. Proc. R. Soc. N. S. Wales.* 50: 187-261, figs. 1-10, pls. 9-19.
- LAMONT, M. E. (1920). A new species of *Clinostomum*. *Occ. Papers Mus. Zool. Univ. Michigan.* (83): 1-5, pl. 1.

- LOOSS, A. (1885). Beitrag zur Kenntnis der Trematode. *Zeitschr. wiss. Zool.* 41: 390-446, pl. 23.
- LUTZ, ADOLPHO (1928). Estudios de Zoologica y parasitologia Venezulanos. 133 pp. 26 pls. Rio de Janeiro.
- MACCAGNO, T. (1932). *Clinostomum complanatum* (Rud.) in *Cobitis taenia* Linn. (Nota preliminare). *Boll. Zool. Napoli.* 3: 285-290, 1 fig.
- MONNIG, H. O. (1926). Helminthological notes. Union So. Africa *Dep't. Agr. Rep'ts Dir. Vet. Ed. and Res.* 11/12 (1): 221-226, 12 figs.
- NICOLL, W. (1914). The trematode parasites of North Queensland. II. Parasites of Birds. *Parasitol.* 7: 105-126. pls. 6, 7.
- OSBORN, H. L. (1911). On the distribution and mode of occurrence in the United States and Canada of *Clinostomum marginatum*, a trematode parasitic in fish, frogs and birds. *Biol. Bull.* 20: 350-356, 1 fig., pl. 1.
(1912). On the structure of *Clinostomum marginatum*, a trematode of the frog, bass and heron. *J. Morph.* 23: 189-229, 1 fig., pls. 1-3.
- PEARSE, T. S. (1933). Parasites of Siamese fishes and crustaceans. *J. Siam. Soc. Nat. Hist. Suppl.* 9: 179-191, 30 figs.
- SOUTHWELL, T. and PRASHAD, B. (1918). Notes from the Bengal Fisheries Laboratory. III. Some fish trematodes. *Rec. Ind. Mus.* 15: 348-350, pl. 12, fig. 1.
- TRAVASSOS, L. (1928). Fauna helminthologica de Matto Grosso. *Mem. Inst. Oswaldo Cruz* 21: 309-341, 13 pls.
- TUBANGUI, M. A. (1933). Trematode parasites of Philippine Vertebrates, VI. Description of new species and classification. *Philippine J. Sc.* 52: 167-197, 6 pls.
- WARD, H. B. (1918). Fresh-water Biology. Ward and Whipple. John Wiley and Sons. New York.
- WITENBERG, G. (1925). Versuch einer Monographie der Trematodenunterfamilie Harmostominae Braun. *Zool. Jahrb. Syst.* 51: 167-245, pls. 1, 2.
- WRIGHT, R. (1879). Contribution to American Helminthology No. 1. *Proc. Canadian Inst.* 1: 54-75, pls. 1, 2.
- YAMAGUTI, S. (1933). Studies on the Helminth Fauna of Japan. I. Trematodes of Birds, Reptiles and Mammals. *Jap. J. Zool.* 5: 1-134, 57 figs.
- References for Rudolphi (1814, 1819) and Diesing (1850), see Braun (1899).

EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. *Corynopoma riisei* Gill showing the yellow grub encysted in the transparent muscle tissue. The worm appears as a dark spot behind the visceral mass.
- Fig. 2. Fish shown in Fig. 1, immediately after death. The cyst was broken open and the living worm removed.

PLATE II.

- Fig. 3. Female "guppy", *Lebistes reticulatus* (Peters), about 1½ inches long, showing five or more *Clinostomum* cysts. Smaller males were also found infected.
- Fig. 4. *Clinostomum complanatum* (Rud. 1814) from the "guppy" shown in Fig. 3. Enlarged about 22X.
- Fig. 5. *Clinostomum complanatum* from the gymnotid, *Sternopygus macrurus*. Enlarged about 22X.